Section 6: Vulnerability Assessment, Risk Analysis and Capabilities

New Sections Included for 2009; Crosswalk Section #8

Critical Facilities

Public Disclosure

This section of the RHMP seeks to describe facilities critical to the continued function and service delivery of cities, utilities, school districts, fire agencies, and King County Government. Many of the critical facilities referenced in this section may be considered as potential terrorist targets. For this reason, the List of specific critical facilities described in "**Annex G - Critical Facilities**" is not subject to public disclosure under the Federal Privacy Act.

Planning Methodology

All public and private facilities are vulnerable to the natural hazards common to the Northwest - high winds, earthquakes, power outages, and flooding. An increased risk of flooding is possible to a great extent from January 2009 and beyond for up to three to five years due to the Howard Hanson Dam situational awareness and potential flooding impacts to the Green River Valley until the Dam repairs are made. Additionally, there are many critical facilities and infrastructures that can also be vulnerable to civil disturbances and terrorism.

For this planning period, the RHMP participants focused their priority on identifying those facilities and infrastructures necessary for their organization to provide critical community services during and after hazard events. They also identified facilities they depend on outside of their organization, as well as those they need to support. It became immediately apparent that there was significant crossover among the disciplines in identifying common critical facilities they operate and/or rely on. Agencies utilized the six major goals and objectives in Section 1 of this Plan as a method to help to identify and prioritize critical facilities.

Because the focus is limited to a small number of 2009 participating agencies, there is significant amount of work to be done in the future to build upon this foundation. In order to develop a comprehensive assessment of all regional critical facilities, infrastructures, and interrelationships it will be necessary to gain more widespread involvement in the planning process. This is one of the objectives tied to Goals Five and Six of the Plan.

Critical Facilities Inventory – Cities in King County

The publicly-owned infrastructure identified as critical to the functioning of a community are described as those with the potential for human casualties or substantial monetary impact from catastrophic loss.

Cities are the most complex of the jurisdiction types participating in this regional hazard mitigation planning effort. Each city is different; some contract for police services, and/or fire services, and/or public works functions, while others do not. In some cases, special purpose districts or cities own their own water treatment and distribution and/or sewer treatment facilities.

Whether owned or leased, all cities identified their city hall locations as critical facilities. Of near equal importance, jurisdictions included police, fire and medical facilities in their essential/critical facilities inventory. Community centers and senior centers were also included.

Certain cities chose to identify facilities critical to the community but outside their direct control. In the later category were schools, hospitals, important transportation intersections or bridges, and both water and sewer utilities. A few cities recognized the importance of communications facilities within their boundaries.

Critical Facilities Inventory – Fire Districts in King County

Fire jurisdictions have a fairly focused mission - fire suppression and basic life-support response. Fire personnel may be called upon to direct evacuations, perform rescue operations as well, and provide hazardous materials response.

All fire jurisdictions acknowledge the importance of their fire stations and major apparatus as critical to their ability to maintain their life safety missions. A few fire agencies recognized the importance of particular transportation intersections and bridges to evacuation routes. Medical facilities, public education facilities, and major hazardous materials facilities or pipelines in a jurisdiction were also identified as critical. Most fire jurisdictions included public education as an integral part of their agency services.

Critical Facilities – Utilities in King County

Utilities in the King County region identified the infrastructure owned by their own various utility districts based on the criticality of those facilities on their own direct operations. The impact of a disaster to safety and utility property could have an impact to other public safety agencies.

These special-purpose districts provide the essential service of water and sewer to the communities served throughout the region. There is a strong association and

mandate that the water districts provide the essential fire protection service to the fire districts. This is evermore a challenge during a major hazardous event.

Both water and sewer districts identified their service lines, and pump and lift stations in their critical facilities inventory. For some cities, such as Mercer Island, and water districts in particular interlink to the larger Seattle Public Utilities (SPU) as their main water, and sometimes only, resource is important. The interlinking of the water system through districts has proven to be essential in providing uninterrupted services throughout the region. A few of the districts noted the essential nature of the office and maintenance buildings. Far more critical were the telemetry and data relays providing operational status for the whole of each system. With power failure it becomes quite a challenge to determine the operational working of the system.

Critical Facilities – King County Government

King County Government has a wide range of facility types that are critical to public health and safety. These include facilities that directly or indirectly support police services, health care, road maintenance, and adult and juvenile detention. The County includes district and superior court service locations as well as a wide range of administrative and licensing service facilities in its list of critical facilities.

Critical Facilities – 2006 King County Flood Hazard Management Plan (*new in 2009, pages 6-3 to 6-22*)

For the 2009 Plan update, critical facilities have been identified by the King County Department of Natural Resources and Parks, Water and Land Resources Division for the six major river basins in King County. Documentation is located in **Annex G**, and this information is not subject to public disclosure under the Federal Privacy Act.

Risk and Vulnerability Assessment

The following section discusses the risk and vulnerability of the flood hazard within the King county planning area. This is a detailed perspective of this hazard that looks at risk in two components:

- Exposure
- Vulnerability

It should be noted that this level of detailed risk assessment has only been completed for the flood hazard. This is due to the availability of data for the flood hazard, which was not available for the other hazards of concern addressed by this Plan. The tool utilized to perform this risk assessment was FEMA's HAZUS-MH (version MR-3). The other hazards of concern will be updated is similar format to the following flood risk assessment under Phase 2 of the planning process described in Section 2, and Section 4, of this Plan.

National Flood Insurance Program (NFIP)

In 1968, Congress created the National Flood Insurance Program (NFIP) in response to the rising cost of taxpayer-funded disaster relief for flood victims and the increasing amount of damage caused by floods. The NFIP makes federally backed flood insurance available to homeowners, renters, and business owners in communities participating in the program. To participate in the NFIP, communities are required to adopt flood damage prevention ordinances that equal or exceed standards specified under section 60.3, Chapter 44 of the Code of Federal Regulations. Participating communities are required to maintain compliance under the NFIP by enforcing their codes and regulations as written, and ensuring that all development that occurs within a FEMA designated floodplain is permitted.

King County has been participating in the NFIP since September 28, 1978. King County has maintained its status in the NFIP since 1978 by implementing one of the strongest floodplain management programs in the County. As the nation's second highest rated CRS community, and its highest rated County, King County has shown a commitment to sound floodplain management policy. Two agencies within King County government assume the responsibility for implementing the County's floodplain management program:

- Department of Development and Environmental Services (DDES)
- Department of Natural Resources and Parks, Water and Land Resources Division (WLRD)

DDES monitors and maintains the regulatory component of the NFIP, while the WLRD monitors both the structural and non-structural floodplain management components for the County. Both of these agencies are fully committed to maintaining the County's compliance and good standing under the NFIP, and well as their CRS class 2 rating by assuring their floodplain regulations continue to exceed the minimum NFIP standards and that development that occurs in the floodplain is consistent with the adopted regulations. King County is also a Cooperating Technical Partner with the Federal Emergency Management Agency to prepare and update flood insurance rate maps using the best available floodplain data. King County's active flood mitigation program purchases or elevates structures located within the floodplain to reduce or permanently eliminate flood damages with a particular focus on properties that are identified as repetitive loss properties under the NFIP. King County also receives CRS credit for the wide range of public outreach activities to floodplain property owners about the danger of living in a floodplain and how they can prepare, respond and recover from flooding. Finally, the 2006 King County Flood Hazard Management Plan is King County's CRS plan of record and is maintained in accordance with the CRS planning guidelines.

NFIP Repetitive Loss Properties

The National Flood Insurance Program (NFIP) defines repetitive loss properties as properties that have had two or more flood insurance claims of at least $1000 each in any 10-year period since 1978. In 2004, King County had 68 repetitive loss properties of which 55 were unmitigated. In 2009 King County has 87 repetitive loss properties of which 58 are unmitigated. Of the 58 unmitigated repetitive loss, 13 are considered severe repetitive loss properties which means they have had had four or more claims of more then $5,000 or two or three claims that cumulatively exceed the buildings value.

For 2009, King County Department of Natural Resources and Parks, Water and Land Resources Division included repetitive loss information in the following section for the six major river basins in King County.[1]

Risk Assessment and Vulnerability Analysis for Flood Hazards

The King County Department of Natural Resources and Parks, Water and Land Resources Division provided a hazard identification and vulnerability analysis for the for the six major river basins for the King County Regional Hazard Mitigation Plan 2009 Plan update. Section 5 of this Plan identified flood hazards and this Section 6 evaluates the exposure and impact to the economy from flooding using the HAZUS-MH MR3 risk assessment tool. Section 6 also identifies land use, development trends, and repetitive loss properties for each of the six major King County river basins listed in Table 6.1.

Note: The 2004 **Table 6-1** has been deleted in 2009 in its entirety and replaced in 2009 with **Table 6.1: Six Major King County River Basins,** September, 2009. 1

Table 6-1: Six Major King County River Basins 1
South Fork Skykomish River
Snoqualmie River
Sammamish River
Cedar River
Green River
White River

1

SOUTH FORK SKYKOMISH RIVER BASIN

Flood Hazard Profile on the South Fork Skykomish River

There are no significant dams or reservoirs on the South Fork Skykomish or its tributaries. With its steep upper basin slopes in high elevation terrain forming the entire watershed, significant runoff can be delivered directly to the flood hazard management corridor along the South Fork Skykomish. Precipitation at these high elevations can generate flooding from rain-on-snow events.

There is currently no functioning U.S. Geological Survey river gage along the South Fork Skykomish in King County or the Town of Skykomish, although the U.S. Geological Survey has had several river gages in the King County portion of the Skykomish River basin in the past. A gage on the South Fork Skykomish near Index (USGS #12133000) recorded data from 1897 to 1982. The flow frequencies listed for the South Fork Skykomish near Index are based on this period of record. The closest available flow measurements are taken downstream in Snohomish County at the Skykomish River near Gold Bar gage (USGS #12134500). Although a U.S. Geological Survey gage on the mainstem of the Skykomish River exists (USGS #12134500), the flows reflect the flow estimates derived from a hydrologic study of the Skykomish and Snoqualmie Rivers.

South Fork Skykomish River Flows

Recurrence Interval (years)	Discharge (cubic feet per second)	
	South Fork Skykomish near Index[a]	Skykomish River at Gold Bar[b]
10	44,300	75,300
50	65,200	106,100
100	74,700	119,300
500	98,500	149,900

FEMA 2005.
Flow estimates based on hydrologic analysis for the Lower Snoqualmie and Skykomish River Revised Flood Insurance Study (Draft, 2005).

Flood Characteristics of the South Fork Skykomish River Basin

The tables below summarize observed flooding characteristics typical for this basin. Understanding the potential flood conditions for a specific area enables the County to identify mitigation alternatives appropriate for the level of risk for that stream or reach. None of the flood events so far have surpassed the 100-year flood flow at the Goldbar gage. Observed flooding depths for this basin vary from less than 1 foot to 6 feet. King County considers the South Fork Skykomish River to have channel migration potential, and regulates this region under the channel migration zone provisions of the King County Critical Areas Ordinance.

King County provides no flood warning on the South Fork Skykomish River System. The only available flow data is collected near the City of Goldbar in Snohomish County, which is significantly downstream from hazard areas in King County. The available data is not useful for providing flood warning to residents in these areas.

South Fork Skykomish River Basin Flow Characteristics

Gage Location	USGS Station Number	River Mile	Drainage Area (square miles)	100-Year Flow (cfs)	Flood of Record, Date & Peak Flow (cfs)
Index	12133000	43.0	535	74,700	Recent Data Not Available

Land Use, Structures and Estimating Potential Losses

The predominant land use in the South Fork Skykomish basin is forest use. Fifty percent of the basin is protected wilderness; 43 percent is zoned for forest production; 6 percent is in rural residential use; and approximately 1 percent is in urban use. Development in the basin has been limited, but much of it has occurred in the floodplain. There are several developments in the Town of Skykomish, the unincorporated communities of Grotto and Baring and scattered residential subdivisions.

South Fork Skykomish Basin Flood Exposure

	EXPOSURE			
Reach	**GBS Value – Structures Exposed to 100-Year Event**	**GBS Value – Contents Exposed to 100-Year Event**	**GBS Value – (Structures and Contents) Exposed to 100-Year Flood**	**% of GBS**
South Fork	$25,236,600	$13,654,860	$38,891,460	31.97%
GBS means General Building Stock This risk assessment was prepared using Level 2 HAZUS – MR3				

South Fork Skykomish Basin Economic Impact

	ECONOMIC IMPACT					
Reach	**100-Year Flood Displaced Population**	**100-Year Flood People Requiring Short-Term Shelter**	**GBS Value Total Structure Damaged by a 100-Year Flood**	**GBS Value Total Contents Damaged by a 100-Year Flood**	**100-Year Flood Total GBS Value (Structures and Contents) Damaged**	**% of Exposed GBS Value**
South Fork	203	133	$5,304,000	$4,191,000	$9,495,000	7.8%
GBS means General Building Stock This risk assessment was prepared using Level 2 HAZUS – MR3						

Development Trends

The South Fork Skykomish River basin has maintained a rural land use environment. Significant development has not and likely will not occur in this area because a large portion of it is protected wilderness area and forest production area. Future land use is projected to be similar to current land use conditions. Only a small increase in households is projected for the 2001 through 2022 planning period.

Repetitive Loss Properties

There are ten FEMA repetitive loss properties in the South Fork Skykomish basin, three of which have been mitigated. The unmitigated properties are located mostly near Baring and Skykomish with one located near Gold Bar. All of these parcels are single-family residences located in the floodway, and it is concluded that the cause of repetitive flooding for all of them is overbank riverine flooding, as reflected by the mapping for the basin.

SNOQUALMIE RIVER BASIN

Flood Hazard Profile on the Upper Snoqualmie River

There are no significant dams on the upper Snoqualmie River to regulated flood flows. All three forks of the Snoqualmie River are relatively steep and confined through most of their course upstream of the confluence area. The combination of no flood control impoundments and steep, confined upstream channels that open to lower gradient floodplains make for areas of widespread flood risk from inundation and channel migration during winter throughout the three forks area. Rain-on-snow events can have a significant effect in this unregulated system with headwaters in the high elevations of the Cascades.

King County flood response efforts do not key to any one river gage, but instead collectively consider flows as the sum of the three forks. The Snoqualmie River near Snoqualmie gage (USGS #12144500) is located at the base of Snoqualmie Falls. U.S. Geological Survey gages are located on the Middle, North and South Forks of the Snoqualmie River. The table below summarizes flow data from these gages.

Upper Snoqualmie River Flows

Recurrence Interval (years)	Discharge (cubic feet per second)			
	Snoqualmie River near Snoqualmie[a]	Middle Fork Snoqualmie[b]	North Fork Snoqualmie[b]	South Fork Snoqualmie[b]
10	51,700	28,000	18,600	9,000
50	71,100	38,300	24,600	13,000
100	79,100	43,800	27,200	15,000
500	95,200	55,800	32,800	19,200

Flow estimates based on hydrologic analysis for the Lower Snoqualmie and Skykomish River Revised Flood Insurance Study (Draft, 2005).
FEMA 2005.

Flood Hazard Profile on the Lower Snoqualmie River

With headwaters and much of the eastern basin highlands in the Cascades and a drainage area of about 600 square miles at Carnation, the lower Snoqualmie basin typically responds to winter rains with flood levels that rise and fall slowly and steadily. With such high elevations and unregulated drainages, rain-on-snow events can be significant. None of the dams and modifications in the basin significantly

alters the flood flows that these mountain conditions produce on the lower mainstem Snoqualmie River. The low-gradient channel of the lower Snoqualmie meets the relatively steeper and faster-responding Skykomish River in Snohomish County, which can result in Skykomish River backwater influencing the lower Snoqualmie as far upstream as Duvall.

Lower Snoqualmie River Flows

	Discharge[a] (cubic feet per second)	
Recurrence Interval (years)	Snoqualmie River at Carnation	Snoqualmie River at Duvall
10	58,200	53,400
50	82,400	75,800
100	91,800	84,600
500	113,300	99,700

Flow estimates based on hydrologic analysis for the Lower Snoqualmie and Skykomish River Revised Flood Insurance Study (Draft, 2005).
The period of record of gage data used to derive values in this table may differ from the period of record currently available.

Flood Hazard Profile on the Tolt River

With its steep upper basin, the Tolt basin has a relatively fast runoff response. The high elevations of the basin can produce rain-on-snow events, which can increase downstream flood magnitude and extent. A typical Tolt River flood reaches its maximum peak 10 to 12 hours before the larger Snoqualmie River. Although the South Fork Tolt River dam is not intended for flood control purposes, dam operations are such that peak flows on the mainstem Tolt have been diminished by about 30 percent relative to pre-dam flows.

The primary gage referenced for Tolt River floods is the Tolt River near Carnation gage (USGS #12148500), which is located on the Tolt River mainstem at River Mile 8.7, with an 82-square-mile drainage area. Flow magnitudes and recurrence intervals are calculated by a standard flood frequency analysis based on flows measured at the USGS #12128500 gage throughout the period of record, which is 1928 to 1931 and 1937 to the present. There is no gage at the Tolt River mouth at River Mile 0.0; flow magnitudes there are calculated based on the relation between the drainage areas at the mouth and at the USGS #12148500 gage. The table below summarizes flow data for the Tolt River.

Tolt River Flows

Recurrence Interval (years)	Discharge (cubic feet per second)[a]	
	Tolt River at Carnation	Tolt River at Mouth
10	11,900	13,900
50	16,700	19,500
100	18,800	22,000
500	23,800	27,800

FEMA 2005.

Flood Hazard Profile on the Raging River

Most Raging River floods occur from during the rainy season in November through February. Raging River flows are unregulated, as there are no major dams in the basin. This relatively steep and short river basin produces floods that are quick to rise to a peak, have high velocity and erosive flows along the steep channel and confined floodplain, and are quick to subside. The upper basin receives some snowfall, so rain-on-snow events can affect flood flows.

The gage used by King County and other agencies for flood monitoring on the Raging River is USGS gage #12145500 near Fall City, which records runoff from approximately 93 percent of the watershed. Flow magnitudes and recurrence intervals were calculated for the FEMA Flood Insurance Study based on flows measured at this gage for the period of record from 1946 to 1992. There is no gage at the Raging River mouth at River Mile 0.0; flow magnitudes there are calculated based on the relationship between the drainage areas at the mouth and USGS gage #12145500. The table below summarizes flow data for the Raging River.

Raging River Flows

Recurrence Interval (years)	Discharge (cubic feet per second)	
	Raging River near Fall City	Raging River at Mouth
10	3,790	4,031
50	5,910	6,286
100	6,970	7,413
500	9,840	10,465

FEMA 2005

Flood Characteristics of the Snoqualmie River Basin

The table below summarizes observed flooding characteristics typical for the Snoqualmie River basin. This table reflects the range of flood conditions by identifiable reach or stream for planning purposes only. Understanding the potential flood conditions for a specific area enables the County to identify mitigation alternatives appropriate for the level of risk for that stream or reach. Flood depths in this basin can vary from less than 1 foot to 6 feet, with significant velocities depending on extent and location within the basin.

Snoqualmie River Basin Flow Characteristics

Gage Location	USGS Station Number	River Mile	Drainage Area (square miles)	100-Year Flow (cfs)	Flood of Record, Date & Peak Flow (cfs)
North Fork	12142000	9.2	64.0	27,200 *a*	02/26/1932; 15,800 cfs
Middle Fork	12141300	55.6	154.0	43,000 *a*	12/02/1977; 30,200 cfs
South Fork	12143400	17.3	41.6	15,000 *a*	11/23/1986; 8,450 cfs
Snoqualmie @ Snoqualmie.	-	40.0	375	79,100 *b*	11/24/1990; 78,800 cfs
Snoqualmie @ Carnation	-	23	603.0	91,800 *b*	11/24/1990; 65,200 cfs

Gage Location	USGS Station Number	River Mile	Drainage Area (square miles)	100-Year Flow (cfs)	Flood of Record, Date & Peak Flow (cfs)
Raging @ Fall City	12145500	2.75	30.6	6,970	11/24/1990; 6,220 cfs
North Fork Tolt	12147500	11.7	39.9	10,300	12/15/1959; 9,560 cfs
South Fork Tolt	12148000	6.8	19.7	9,160	23/15/1959; 6,500 cfs
Tolt @ Carnation	12148500	8.7	81.4	18,800	12/15/1959; 17,400 cfs
FEMA 2005. Period of record of USGS gage data used to derive values in table may differ from period of record currently available. Flow estimates based on hydrologic analysis for the Lower Snoqualmie and Skykomish River Revised Flood Insurance Study (Draft 2005).					

Land Use, Structures and Estimating Potential Losses

The major portion of the Snoqualmie River basin floodplain is in unincorporated King County, with small but significant portions in the cities of North Bend, Snoqualmie, Duvall and Carnation. Development throughout the incorporated portions of the Snoqualmie River floodplain is mainly commercial and residential. Agricultural and residential development predominates in unincorporated King County along the lower and upper portions of the river.

Snoqualmie Basin Flood Exposure

	EXPOSURE			
Reach	**GBS Value Structures Exposed to 100-Year Event**	**GBS Value Contents Exposed to 100-Year Event**	**GBS Value (Structures and Contents) Exposed to 100-Year Flood**	**% of GBS**
Upper Basin	$157,803,400	$86,883,140	$244,686,540	15.32%
Lower Basin	$124,937,400	$70,004,940	$194,942,340	3.86%
Basin Total	**$282,740,800**	**$156,888,080**	**$439,628,880**	
GBS means General Building Stock This risk assessment was prepared using Level 2 HAZUS – MR3 3				

Snoqualmie Basin Economic Impact

ECONOMIC IMPACT						
Reach	**100-Year Flood Displaced Population**	**100-Year Flood People Requiring Short-Term Shelter**	**GBS Value Total Structure Damage by a 100-Year flood**	**GBS Value Total Contents Damage by a 100-Year flood**	**100-Year Flood Total GBS Value (Structures and Contents) Damaged**	**% of Exposed GBS Value**
Upper Basin	1814	1497	$37,386,000	$25,161,000	$62,547,000	3.9%
Lower Basin	1987	1269	$56,283,000	$43,041,000	$99,324,000	2.0%
Basin Total	**3,801**	**2,766**	**$93,669,000**	**$68,202,000**	**$161,871,000**	
GBS means General Building Stock This risk assessment was prepared using Level 2 HAZUS – MR3 3						

Development Trends

Much of the urbanization of the watershed has been contained in high density incorporated areas. While urban areas constitute only about 3 percent of the total watershed area, they make up a significant portion of some subwatersheds including Coal Creek (50 percent), mainstem Snoqualmie (15 percent), Patterson Creek (10 percent), and Cherry Creek (6 percent). The potential for high density development is increased by the presence of vested lots and plats, particularly in the Patterson and Ames Creeks areas.

Repetitive Loss Properties

The upper Snoqualmie River basin has 31 repetitive loss properties, 16 of which have been mitigated. Of the 15 unmitigated repetitive loss properties, 10 are classified as severe repetitive loss properties. These repetitive loss properties tend to be clustered around the cities of Snoqualmie and North Bend. Of the 13 unmitigated repetitive loss properties, all are single-family residential. All but two property lies within a mapped 100-year floodplain, so it is concluded that the main cause of repetitive flooding for this basin is overbank riverine flooding reflected by the mapping for the basin. The two properties outside the 100-year floodplain are located in a closed depression that are impacted by the outflow from Brewster Lake.

The lower Snoqualmie River basin has 19 repetitive loss properties of which two have been mitigated. Of the 17 unmitigated repetitive loss properties, 2 are classified as severe repetitive loss properties Of these 17 unmitigated properties, all but one are single-family residential and with one being a golf course club house. All lies within a mapped 100-year floodplain, so it is concluded that the main cause of repetitive flooding for this basin is overbank riverine flooding reflected by the mapping for the basin.

SAMMAMISH RIVER BASIN

Flood Hazard Profile on the Sammamish River

Water from the Lake Sammamish basin originally flowed into Lake Washington through the old Sammamish Slough, a widely meandering, low-gradient river bordered by extensive wetlands and floodplains. When Lake Washington was lowered by 9 feet after construction of the Lake Washington Ship Canal in 1912, property owners along the slough formed a drainage district to straighten and deepen the channel in order to reclaim the adjacent lands for agriculture. The U.S. Army Corps of Engineers completed river channelization in 1966 and constructed a low weir at the outlet of Lake Sammamish. The weir outlet slows release from Lake Sammamish during low-flow periods. During high flows, the weir is completely submerged by the river, acting as an uncontrolled spillway. The project was designed to pass approximately a 40-year springtime flood, equivalent to a 10-year winter storm, over the weir without the water surface elevation in Lake Sammamish exceeding 29.0 feet. The result of the project has been significantly reduced the frequency and severity of flooding risks around the lake and adjacent to the river.

Flows in the river are recorded at the USGS gage #12125200, currently operated by King County, located at NE 116th Street in Redmond. Lake Sammamish surface water levels are also recorded near Vasa Park at USGS gage #12122000. The table below summarizes flow data used for current floodplain mapping. These flows are considerably out of date. The hydraulic model and topographic maps used to establish flows and create the maps were developed in 1966, based on conditions at the time. Recent hydrologic studies have updated some of the flow estimates, and the hydraulic model has been updated for a limited selection of parameters and locations along the river. King County is in the process of updating these maps to reflect changes in topography and hydrology over the last 40 years.

Lake Sammamish Levels and Sammamish River Flows

Recurrence Interval (years)	Surface Elevation (NGVD 1929)[a]	Discharge (cubic feet per second)[a]	
	Lake Sammamish	Redmond downstream of Bear Creek	Sammamish River at Mouth
10	29.0	1,740	2,300
50	31.3	2,480	3,300
100	32.5	2,830	4,300
500	34.0	3,820	5,600

FEMA 2005.
The period of record of USGS gage data used to derive values in table may differ from the period of record currently available.
The FEMA Flood Insurance Study for the Sammamish River indicates that Lake Washington is regulated to between 13.2 and 15.0 feet NGVD 1929 (FEMA, 2005).

Flood Characteristics of the Sammamish River Basin

The table below summarizes observed flooding characteristics typical for this basin. The table shows events that reached above Phase III at the Hobart gage for Issaquah Creek unless otherwise indicated. Warning time estimates were not available for the Sammamish River basin. King County collects gage information only on Issaquah Creek.

Sammamish River Basin Flow Characteristics

Gage Location	USGS Station Number	River Mile	Drainage Area (square miles)	100-Year Flow (cfs) [a,b]	Flood of Record, Date & Peak Flow (cfs)
Sammamish River @ Mouth	12122000	5.6	99.6	4,300	-
Issaquah Creek @ Mouth	12121600	1.2	55.6	3,960	01/09/1990; 3,200 cfs

FEMA 2005.
Period of record of USGS gage data used to derive values in table may differ from period of record currently available.

Land Use, Structures and Estimating Potential Losses

In recent decades, substantial development has occurred in the Sammamish River basin. Extensive commercial and residential developments have been constructed throughout the floodplain. There are also several parks and other recreational facilities. Land uses in the upper 10 miles are mainly recreational and agricultural as well as urban commercial, specifically in the Cities of Redmond and Woodinville. The lower 5 miles include significant residential and commercial developments as well as some open space areas.

Sammamish Basin Flood Exposure

	EXPOSURE			
Reach	**GBS Value – Structures Exposed to 100-Year Event**	**GBS Value – Contents Exposed to 100-Year Event**	**GBS Value – (Structures and Contents) Exposed to 100-Year Flood**	**% of GBS**
Basin Total	**$89,551,200**	**$58,018,120**	**$147,569,320**	**1.17%**
GBS means General Building Stock This risk assessment was prepared using Level 1 HAZUS – MR3 3				

Sammamish Basin Economic Impact

ECONOMIC IMPACT						
Reach	**100-Year Flood Displaced Population**	**100-Year Flood People Requiring Short-Term Shelter**	**GBS Value Total Structure Damaged by a 100-Year Flood**	**GBS Value Total Contents Damaged by a 100-Year Flood**	**100-Year Flood Total GBS Value (Structures and Contents) Damaged**	**% of Exposed GBS Value**
Basin Total	**586**	**239**	**$8,289,000**	**$22,868,000**	**$31,157,000**	**0.2%**
GBS means General Building Stock This risk assessment was prepared using Level 1 HAZUS – MR3 3						

Development Trends

The Sammamish River basin has been urbanizing rapidly since the 1950s. Future development is expected to continue throughout the Sammamish basin. Bellevue, Issaquah, Kirkland and Redmond have designated potential annexation areas, some of which are within the floodplain.

Repetitive Loss Properties

There only one repetitive loss properties in the Sammamish River basin and it has not been mitigated. This property is located outside the 100-year floodplain which means that the flooding was likely due to storm water drainage problems.

Issaquah Creek has two unmitigated repetitive loss properties which are not clustered together. One is a single-family residential property and the other is a mobile home. Both lie within a mapped 100-year floodplain, so it is concluded that

the cause of repetitive flooding for this basin is overbank riverine flooding reflected by the mapping for the basin.

CEDAR RIVER BASIN

Flood Hazard Profile on the Cedar River

The hydrology and hydraulics of the Cedar River basin have been substantially altered from the natural conditions. The lowest mile of the river was rerouted by the U.S. Army Corps of Engineers in 1914. The mouth of the Cedar River, which previously drained to the Black River and subsequently the Green River and into Puget Sound, was diverted into Lake Washington through a straightened, dredged channel with rock-stabilized banks. In the upper Cedar River watershed, the City of Seattle operates three dams designed for municipal water supply and hydropower purposes: the Masonry Dam, the reconstructed Crib Dam or Overflow Dike, and the Landsburg Diversion.

The first dam on the Cedar River was the rock-fill, timber-structured Crib Dam, constructed in 1903 and rebuilt as the Overflow Dike in 1987, at the outlet of what is now Chester Morse Lake. Masonry Dam controls storage capacity in Chester Morse Lake and the outflows used to produce hydroelectric power. Eleven miles farther downstream is the Landsburg Diversion constructed in 1899, which diverts municipal and industrial water supply for the City of Seattle. The Masonry Dam was not designed or built to serve as a flood control dam; however, in addition to its hydropower generation and water supply functions, it has the capacity to store up to 15,000 acre-feet of flood water. However existing flood-prone areas downstream remain vulnerable to severe flood risks.

The two primary gages used for monitoring flood flows along the Cedar River are the Cedar River at Renton (USGS #12119000) and the Cedar River at Landsburg (USGS #12117500). The table below summarizes flow data.

Cedar River Flows

Recurrence Interval (years)	Discharge (cubic feet per second)[a]	
	Cedar River at Renton	Cedar River at Landsburg
10	5,940	4,880
50	9,860	8,340
100	12,000	10,300
500	18,400	16,100

Final Flood Frequency Analysis Curve for Year 2000 Floodplain Mapping on the Lower Cedar River, March 2000; included with King County's submittal to FEMA for a revised Flood Insurance Study for the Cedar River.

Flood Characteristics of the Cedar River Basin

The table below summarizes observed flooding characteristics typical for this basin.

Cedar River Basin Flow Characteristics

Gage Location	USGS Station Number	River Mile	Drainage Area (square miles)	100-Year Flow (cfs) [a]	Flood of Record, Date & Peak Flow (cfs)
Cedar Falls	12116500	33.2	84.2	8,930	11/24/1990; 12,300
Landsburg	12117500	23.4	121.0	10,300	11/18/1911; 14,200
Renton	12119000	1.6	184.0	12,000	11/24/1990; 10,600

Final Flood Frequency Analysis Curve For Year 2000 Floodplain Mapping on the Lower Cedar River march 2000 include with King county's submittal to FEMA for a revised Flood Insurance Study for the Cedar River. Period of record of USGS gage data used to derive values in table may differ from period of record currently available.

Land Use, Structures and Estimating Potential Losses

Land use in the Cedar River basin is dominated by forest uses (60.6 percent). The other main uses are residential; 21.3 percent can be classified as low-density development, 7.7 percent as medium and 0.9 percent as high density development. High-density development is located primarily in the Cities of Renton and Maple Valley.

Cedar River Basin Flood Exposure

	EXPOSURE			
Reach	**GBS Value – Structures Exposed to 100-Year Event**	**GBS Value – Contents Exposed to 100-Year Event**	**GBS Value – (Structures and Contents) Exposed to 100-Year Flood**	**% of GBS**
Basin Total	**$61,561,700**	**$30,394,070**	**$91,955,770**	**0.78%**

GBS means General Building Stock
This risk assessment was prepared using Level 2 HAZUS – MR3 3

Cedar River Basin Economic Impact

ECONOMIC IMPACT						
Reach	**100-Year Flood Displaced Population**	**100-Year Flood People Requiring Short-Term Shelter**	**GBS Value Total Structure Damaged by a 100-Year Flood**	**GBS Value Total Contents Damaged by a 100-Year Flood**	**100-Year Flood Total GBS Value (Structures and Contents) Damaged**	**% of Exposed GBS Value**
Basin Total	**1,168**	**905**	**$11,659,000**	**$7,846,000**	**$19,505,000**	**0.2%**

GBS means General Building Stock
This risk assessment was prepared using Level 2 HAZUS – MR3 3

Development Trends

The greater part of the Cedar River floodplain is in unincorporated King County, with a smaller portion in the City of Renton. There is commercial, industrial and residential development throughout the incorporated areas of the Cedar River floodplain. Residential development has also occurred in unincorporated King

County along the upper floodplain, which is likely due to its proximity to Renton. There is expected to be a significant amount of growth in Renton during the 2001 to 2022 planning period.

Repetitive Loss Properties

There are 17 repetitive loss properties in the Cedar River basin, seven of which are mitigated. The 10 unmitigated properties are located in no consistent location in the basin and all are single-family residential properties. They all lie within a mapped 100-year floodplain, so it is concluded that the cause of repetitive flooding for this basin is overbank riverine flooding reflected by the mapping for the basin.

GREEN RIVER BASIN

Flood Hazard Profile on the Green River

The primary control on flooding characteristics is Howard Hanson Dam, at approximately River Mile 64. Howard Hanson Dam was completed in 1962 and is operated by the U.S. Army Corps of Engineers, with a primary purpose of flood control and secondary purpose of water conservation and municipal water supply. During the summer, low flows are augmented through release of waters stored in a conservation pool in the reservoir behind Howard Hanson Dam. Additional flows are stored and released to supply summer withdrawal needs at the Tacoma Public Utilities water supply diversion structure downstream.

The target flood control parameter for Howard Hanson Dam is a Congressionally authorized flow of 12,000 cubic feet per second at the Green River near Auburn gage (USGS #12113000), at about River Mile 31 in Auburn. Operations at Howard Hanson Dam that target flows at Auburn must also consider the magnitude and timing of local inflows from tributaries such as Soos and Newaukum Creeks.

Placing a cap of 12,000 cubic feet per second on Green River flood flows at Auburn has reduced all larger flood events to what would be the pre-dam equivalent of a 2-year event at Auburn. Howard Hanson Dam is capable of storing floods up to and including a 500-year reservoir inflow event and converting them to a discharge at Auburn of the historical 2-year flood, with such flows extending over a much longer duration than they would under natural conditions. However, damage to the Howard Hanson Dam in the January 2009 flood event will impact the ability of the dam to operate at the design capacity. Dam operations in combination with the lower Green levees contain most flood events from Auburn downstream to the mouth when the dam is operating at its design capacity. The table below summarizes flow data.

Green River Flows

Recurrence Interval (years)	Discharge at Auburn Gage[a, b] (cubic feet per second)
10	12,000
50	12,000
100	12,000
500	12,000

FEMA 2005
Affected by regulation at Howard Hanson Dam.

Flood Characteristics of the Green River Basin

The table below summarizes observed flooding characteristics typical for this basin.

Green River Basin Flow Characteristics

Gage Location	USGS Station Number	River Mile	Drainage Area (square miles)	100-Year Flow (cfs)[a,b]	Flood of Record, Date & Peak Flow (cfs)
Howard Hanson Dam	12105900	63.8	221.0	Maximum flow release to meet target of 12,000 cfs at Auburn	12/21/1960; 12,200 (pre-dam)
Auburn	12113000	32.0	399.0	12,000 (as regulated by Howard Hanson Dam)	11/23/1959; 28,100 (pre-dam)
Tukwila	12113350	NA	440.0	12,400	01/31/1965; 12,100

FEMA (2005)
Affected by regulation at the Howard Hanson Dam

Land Use, Structures and Estimating Potential Losses

Land use in the Green River basin varies significantly among the lower, middle and upper portions. The land in the Upper Green River is primarily forestland. The Middle Green River is primarily farmland and a mix of urban and rural residential. The major land uses are residential (50 percent), forestry (27 percent) and agriculture (12 percent). Several large state and county parks abut the river in this segment. The Lower Green River contains less farmland and is mainly urban. Except for occasional stretches of parkland, a mixture of residential, commercial and industrial land uses are the main land uses. Residential development (50 percent), industrial development (17 percent), and commercial development (10 percent) are the primary uses along the Lower Green River.

Green River Basin Flood Exposure

	EXPOSURE			
Reach	**GBS Value – Structures Exposed to 100-Year Event**	**GBS Value – Contents Exposed to 100-Year Event**	**GBS Value – (Structures and Contents) Exposed to 100-Year Flood**	**% of GBS**
Basin Total	**$76,706,600**	**$39,647,160**	**$116,353,760**	**1.08%**

GBS means General Building Stock
This risk assessment was prepared using Level 2 HAZUS – MR3 3

Green River Basin Economic Impact

IMPACT ECONOMY						
Reach	**100-Year Flood Displaced Population**	**100-Year Flood People Requiring Short-Term Shelter**	**GBS Value Total Structure Damaged by a 100-Year Flood**	**GBS Value Total Contents Damaged by a 100-Year Flood**	**100-Year Flood Total GBS Value (Structures and Contents) Damaged**	**% of Exposed GBS Value**
Basin Total	**1,374**	**841**	**$32,464,000**	**$27,920,000**	**$60,384,000**	**0.6%**
GBS means General Building Stock This risk assessment was prepared using Level 2 HAZUS – MR3 3						

Development Trends

The Green River basin has been urbanizing since the 1970s. In the 1990s, Black Diamond, Enumclaw and Covington experienced rapid growth. Land development estimates indicate that the largest areas of future development will be in the Lower and Middle Green River areas.

Repetitive Loss Properties

Based on the County's review of repetitive loss data provided by FEMA, there are three repetitive loss properties in the Green River basin that have not been mitigated. These properties are all single-family residential. One property is located at the south end of Horseshoe Land and the other two are in the 100-year floodplain of the Green River.

There are also three unmitigated repetitive loss properties located on Vashon Island, which are not technically part of the Green River basin but rather are part of the larger Puget Sound Drainage.

WHITE RIVER BASIN

Flood Hazard Profile on the White River

With headwaters on Mount Rainier glaciers, snowmelt also increases White River flows in late summer, but not to a level of flood concern. The primary determinant for flooding characteristics in the White River is the presence and flow control operations of Mud Mountain Dam.

As a sole-purpose flood protection facility near River Mile 30, Mud Mountain Dam reduces peak flood flows and releases the stored water at a lower flow over a longer duration than would occur if the dam were not in place. Mud Mountain Dam is operated by the U.S. Army Corps of Engineers to control floods along the lower Puyallup River. Its operation is targeted to the Puyallup River at the Puyallup gage (USGS #12101500). Although targeted for the Puyallup River, theses dam operations also result in decreased flood flows along the White River relative to pre-

dam conditions. Mud Mountain Dam is operated to a target maximum flow of 45,000 cubic feet per second at the Puyallup gage. In addition to this primary flood control authority directed toward the Puyallup River, the U.S. Army Corp of Engineers operates Mud Mountain Dam to achieve flood benefits on the White River as is feasible. The table below summarizes White River flow data. Flood frequencies for the White River were obtained from a backwater channel-capacity study by the U.S. Army Corps of Engineers of Engineers completed in 1974.

White River Flows

Recurrence Interval (years)	White River near Auburn Discharge[a] (cubic feet per second)
10	15,870
50	17,600
100	18,370
500	20,700

FEMA 2005
The period of record of gage data used to derive values in this table may differ from the period of record currently available.

Over the course of 90 years, flow control at Mud Mountain Dam and the Puget Sound Energy diversion to Lake Tapps have had a dramatic effect on the natural flow regimes of the basin. In this sediment-rich river, such changes in flow regime affect sediment transport capacity, geomorphic processes, channel patterns and fish habitat. Rapid changes in sediment levels and shifting channel locations in turn affect inundation and channel migration flood hazards.

Flood Characteristics of the White River Basin

The table below summarizes observed flooding characteristics typical for this basin. Understanding the potential flood conditions for a specific area enables the County to identify mitigation alternatives appropriate for the level of risk for that stream or reach.

White River Basin Flow Characteristics

Gage Location	USGS Station Number	River Mile	Drainage Area (square miles)	100-Year Flow (cfs) [a]	Flood of Record, Date & Peak Flow (cfs)
Buckley	12098500	27.9	401.0	17,600 (maximum release from Mud Mountain Dam)	12/01/1933; 28,000 (pre-dam)
Auburn	12100496	6.30	464.0	18,370	02/10/1996; 15,000
Greenwater	12097500	1.10	73.5	5,776	12/02/1977; 10,500

FEMA 2005.

Land Use, Structures and Estimating Potential Losses

Approximately 175 square miles in the White River basin is owned and managed by the Mount Baker-Snoqualmie National Forest. Another 90 square miles of the basin is part of Mount Rainier National Park. In this upper portion, the basin is mainly

undeveloped but includes some scattered residential and commercial property around Greenwater. In the lower areas of the basin, there are some agricultural lands and a mix of residential, commercial and industrial uses closer to and in the cities. Upstream of the Muckleshoot Indian Reservation, the river is unconstrained and the valley is mostly undeveloped.

FEMA floodplain mapping shows 3,025 acres of mapped floodplain in the White River basin. Approximately 74 percent of this, or 2,246 acres, is along the White River mainstem. The table below defines the mapped floodplain in terms of incorporated and unincorporated King County. One of the major risks in the White River basin is that there are significant channel migration hazards related to the river's significant sediment load and debris local, especially in the upper basin. Floodplain maps for the White River are outdated and do not reflect recent changes in several channel locations.

White River Basin Flood Exposure

	EXPOSURE			
Reach	**GBS Value –Structures Exposed to 100-Year Event**	**GBS Value – Contents Exposed to 100-Year Event**	**GBS Value – (Structures and Contents) Exposed to 100-Year Flood**	**% of GBS**
Basin Total	**$21,772,400**	**$11,006,160**	**$32,778,560**	**2.38%**
GBS means General Building Stock This risk assessment was prepared using Level 2 HAZUS – MR3 3				

White River Basin Economic Impact

	ECONOMIC IMPACT					
Reach	**100-Year Flood Displaced Population**	**100-Year Flood People Requiring Short-Term Shelter**	**GBS Value Total Structure Damaged by a 100-Year Flood**	**GBS Value Total Contents Damaged by a 100-Year Flood**	**100-Year Flood Total GBS Value (Structures and Contents) Damaged**	**% of Exposed GBS Value**
Basin Total	**529**	**275**	**$10,433,000**	**$9,405,000**	**$19,838,000**	**1.4%**
GBS means General Building Stock This risk assessment was prepared using Level 2 HAZUS – MR3 3						

Development Trends

The majority of the White River basin is in unincorporated King County, with a smaller portion in the cities and the Muckleshoot Indian Tribe Reservation. There is commercial, industrial and residential development throughout the incorporated areas of the White River floodplain. The majority of development is along the White River in the Auburn and Pacific area. This area has significant potential for new residential, commercial and industrial development.

Repetitive Loss Properties

There currently are no unmitigated repetitive loss properties in this basin. However, at one time, this basin included a single repetitive loss property with the most flood insurance claims of any property in the County. This property was located along the Boise Creek reach of this basin, and was mitigated through a property acquisition by King County in 2000. This is end of the King County Flood Control District data. [2]

INCORPORATED CITIES *(new for 2009)*

There are 39 incorporated citied within King County. Some of these cities, such as Snoqualmie, North Bend, Renton, Tukwila, Ken, Auburn and Pacific are located along King County's major river systems and are subjected to the same risks identified above. The tables below shows the exposure and impact to the economy of these 39 cities using HAZUS modeling based on census tract data, King County Assessor's data and geographic information system (GIS) data for flood hazards.

Unincorporated Cities Flood Exposure

	Estimated 2009 Population (1)	**Building Count (2)**	**GBS Value Structure in $ Exposed to a 100-Year Flood Event (2)**	**GBS Value Contents in $ Exposed to a 100-Year Flood Event (2)**	**GBS Value (Structure and contents in $) Exposed to a 100-Year Flood Event (2)**	**% of GBS**
Algona	2,760	0	$0	$0	$0	0.00%
Auburn	60,820	346	$244,168,500	$260,659,350	$504,827,850	5.44%
Beaux Arts	315	0	$0	$0	$0	0.00%
Bellevue	120,600	235	$108,611,300	$75,242,830	$183,854,130	0.66%
Black Diamond	4,180	7	$261,000	$136,500	$397,500	0.08%
Bothell	17,260	82	$380,780,700	$417,797,970	$798,578,670	29.24%
Burien	31,890	267	$106,395,100	$54,278,210	$160,673,310	3.65%
Carnation	1,910	85	$20,161,800	$12,203,580	$32,365,380	13.12%
Clyde Hill	2,815	0	$0	$0	$0	0.00%
Covington	17,530	87	$13,858,500	$7,267,950	$21,126,450	1.03%
Des Moines	29,270	125	$37,906,800	$27,171,480	$65,078,280	1.97%
Duvall	5,980	7	$2,294,700	$2,524,170	$4,818,870	0.52%
Enumclaw	11,460	0	$0	$0	$0	0.00%
Federal Way	88,580	92	$26,231,700	$13,533,450	$39,765,150	0.38%
Hunts Point	465	0	$0	$0	$0	0.00%
Issaquah	26,890	380	$149,405,200	$118,348,920	$267,754,120	4.65%
Kenmore	20,450	118	$26,443,800	$15,722,580	$42,166,380	1.75%
Kent	88,380	1069	$1,816,502,229	$1,982,705,452	$3,799,207,681	26.69%
Kirkland	49,010	12	$6,592,400	$7,251,640	$13,844,040	0.15%

Lake Forest Park	12,820	35	$10,390,000	$5,398,400	$15,788,400	0.87%
Maple Valley	20,840	0	$0	$0	$0	0.00%
Medina	2,970	0	$0	$0	$0	0.00%
Mercer Island	22,720	0	$0	$0	$0	0.00%
Milton	830	0	$0	$0	$0	0.00%
Newcastle	9,925	0	$0	$0	$0	0.00%
Normandy Park	6,485	81	$24,969,000	$12,511,500	$37,480,500	2.50%
North Bend	4,760	818	$187,507,100	$147,525,010	$335,032,110	42.86%
Pacific	6,200	37	$5,867,000	$3,983,500	$9,850,500	2.06%
Redmond	51,890	196	$457,748,500	$500,670,350	$958,418,850	7.76%
Renton	83,650	263	$346,655,800	$368,864,780	$715,520,580	5.69%
Sammamish	40,670	240	$97,905,000	$49,339,500	$147,244,500	1.70%
SeaTac	25,730	6	$258,100	$207,110	$465,210	0.01%
Seattle	602,000	675	$220,834,815	$164,123,296	$384,958,111	0.34%
Shoreline	54,320	16	$4,319,000	$2,159,500	$6,478,500	0.10%
Skykomish	210	171	$17,471,200	$13,009,520	$30,480,720	75.27%
Snoqualmie	9,730	628	$167,489,200	$117,606,120	$285,095,320	14.97%
Tukwila	18,170	74	$67,211,000	$73,219,900	$140,430,900	2.96%
Woodinville	10,670	16	$32,538,700	$35,792,570	$68,331,270	2.72%
Yarrow Point	965	0	$0	$0	$0	0.00%

(1) 2009 Washington Office of Financial Management estimated population.
(2) Exposure numbers were estimated using King County parcel centroids and Assessor data.

Unincorporated Cities Economic Impact

	100-year Flood Event - Displaced Population	100-year Flood Event - People Requiring Short-Term Shelter	GBS Value Structure in $ Damaged by a 100-Year Flood Event (1)	GBS Value Contents in $ Damaged by a 100-Year Flood Event (1)	GBS Value (Structure and Contents in $) Damaged by a 100-Year Flood Event (1)	% of GBS
Algona	0	0	$0	$0	$0	0.0%
Auburn	2666	2519	$45,514,000	$81,689,000	$127,203,000	1.4%
Beaux Arts	0	0	$0	$0	$0	0.0%
Bellevue	1024	827	$4,617,000	$5,545,000	$10,162,000	0.0%
Black Diamond	0	0	$0	$0	$0	0.0%
Bothell	554	476	$37,641,000	$81,060,000	$118,701,000	4.3%
Burien	14	1	$46,000	$56,000	$102,000	0.0%
Carnation	1323	1021	$5,974,000	$6,880,000	$12,854,000	5.2%
Clyde Hill	0	0	$0	$0	$0	0.0%
Covington	59	28	$45,000	$54,000	$99,000	0.0%
Des Moines	36	36	$212,000	$136,000	$348,000	0.0%

Duvall	9	1	$1,033,000	$2,096,000	$3,129,000	0.3%
Enumclaw	56	37	$875,000	$1,331,000	$2,206,000	0.2%
Federal Way	0	0	$0	$0	$0	0.0%
Hunts Point	0	0	$0	$0	$0	0.0%
Issaquah	1039	868	$15,821,000	$25,531,000	$41,352,000	0.7%
Kenmore	682	606	$2,158,000	$1,990,000	$4,148,000	0.2%
Kent	8946	8387	$250,828,000	$602,286,000	$853,114,000	6.0%
Kirkland	186	164	$222,000	$264,000	$486,000	0.0%
Lake Forest Park	0	0	$0	$0	$0	0.0%
Maple Valley	0	0	$0	$0	$0	0.0%
Medina	0	0	$0	$0	$0	0.0%
Mercer Island	0	0	$0	$0	$0	0.0%
Milton	0	0	$0	$0	$0	0.0%
Newcastle	0	0	$0	$0	$0	0.0%
Normandy Park	121	81	$4,429,000	$2,986,000	$7,415,000	0.5%
North Bend	2345	2109	$21,562,000	$36,122,000	$57,684,000	7.4%
Pacific	123	123	$1,373,000	$991,000	$2,364,000	0.5%
Redmond	2577	2485	$29,709,000	$62,722,000	$92,431,000	0.7%
Renton	713	509	$66,883,000	$147,987,000	$214,870,000	1.7%
Sammamish	13	3	$2,762,000	$1,432,000	$4,194,000	0.0%
SeaTac	11	0	$17,000	$34,000	$51,000	0.0%
Seattle	317	83	$657,000	$443,000	$1,100,000	0.0%
Shoreline	0	0	$0	$0	$0	0.0%
Skykomish	164	43	$2,760,000	$4,100,000	$6,860,000	16.9%
Snoqualmie	1653	1442	$11,322,833	$18,474,095	$29,796,928	1.6%
Tukwila	128	36	$44,693,000	$82,886,000	$127,579,000	2.7%
Woodinville	9	1	$3,779,000	$6,425,000	$10,204,000	0.4%
Yarrow Point	0	0	$0	$0	$0	0.0%

(1) The valuation of general building stock and loss estimates determined in King County were based off an updated HAZUS-MH MR3 general building stock dataset at a Census Block analysis level.

Vulnerable Populations Defined

The Regional Profile, provided in Section 3, describes the demographic setting of the King County region, its cities, economy and resources, and examines potential at-risk populations. In this section, we will evaluate *vulnerability* in more detail.

People at Risk[4]

Densely Populated Areas

More than 96 percent of King County's population lives in densely settled urbanized areas. The current growth pattern, both urban and rural, affects how agencies prepare for emergencies as changes in the population and development can increase risks associated with hazards. Growth is being directed into Urban Growth Areas (UGAs) of the County which can be more vulnerable to certain hazards, such as earthquakes. Comparing the hazard maps located in **Section 5: HIVA** and **Map 3-1: Population Density** provides an idea of where populations (and facilities) can be impacted.

Populations with Special Needs

The ability to prepare for and recover from a disaster varies among population groups. Research on various population groups and disasters found that it took some populations longer to recover from a disaster for a variety of reasons. These population groups include minorities, people with language barriers, the disabled, the elderly, those with low income, and young children.

- *Minorities:* People from non-white population groups generally experience longer recoveries due to lower incomes, savings and insurance; their difficulty accessing insurance; and their using aid and relief organizations differently than was anticipated. Language and cultural differences can pose difficulties in some populations understanding and implementing preparedness and mitigation actions as well as accessing and using available disaster relief resources.

- *People with Language Barriers*: Since nearly one in five residents in King County do not speak English as their primary language, there is a significant segment of the population may have a language barrier that prevents them from preparing for a disaster, responding to an event, or applying for assistance after a disaster. In 2009, 127 languages are spoken in King County reflecting great cultural diversity.

- *Disabled Persons:* People with disabilities often are left out of community preparedness activities for a disaster. They have complex challenges because of hearing, sight, mobility, or mental impairments. Additionally, a significant percentage of working-age people with disabilities do not work. These factors may make it difficult for the person with disabilities to prepare in advance of a disaster.

- *Elderly:* The elderly may be overlooked in preparedness and recovery activities; their age could lead them to have trouble after a disaster, perhaps not qualify for loans, or become disabled because of the disaster.

- *Low Income:* The amount of money people have influences what type of housing they live in, whether they can engage in mitigation actions, and how long it takes to recover. Income is based on a number of factors, including the individual, the economy, availability of jobs, and educational opportunity among others. Expenses can vary by location – rural places are cheaper to live but have fewer jobs, while urban areas can be costly, especially for renters.

- *Young Children:* The number of children attending school is a concern because many of the school buildings they spend considerable time in each day are older and potentially more vulnerable to the effects of disaster.

Property at Risk

Housing

The year housing was built is important for mitigation. The older a home is, the greater the risk of damage from natural disasters. Homes built after 1980 are more likely to have been constructed to current standards for hazards such as floods, high winds, snow loads, and earthquake. About two-thirds of the homes in King County were built before 1960 when codes were less restrictive.

Natural Resources at Risk

Conserving King County's rural and natural resource lands is integral to providing diversity in lifestyle choices, continuing farming and forestry economies, protecting environmental quality, fisheries, salmon streams, and wildlife habitat and maintaining a link to King County's resource-based heritage.

Capability Assessment

A capability assessment is an integral part of the planning process in which you identify, review and analyze what your community is doing to reduce risk. A capability assessment also allows you to identify a framework that is in place or should be in place for implementation of new mitigation actions. A capability assessment has 2 components: an inventory of a jurisdiction's mission, programs and policies; and an analysis of its capacity to carry them out. By completing a capability assessment, a community will learn how or whether they will be able to implement certain mitigation activities by determining:

- Certain types of actions that may be prohibited by law
- Limitations that may exist on undertaking actions; and
- The range of local regulatory, technical and financial resources available to assist in implementing the actions.

The following tables illustrate the regulatory, technical and financial capabilities of the King County Municipal government. It should be noted that each local government that links to this Plan under Phase 2 of this planning process will assess their individual capabilities in this format.

LEGAL AND REGULATORY CAPABILITY					
Regulatory Tools (Codes, Ordinances., Plans)	**Local Authority (Y or N)**	**Prohibitions (State or Federal)**	**Higher Jurisdictional Authority (Y or N)**	**State Mandated (Y or N)**	**Comments**
1) Building Code	Y	N	N	Y	Building and Construction Standards (King County Code Title 16); NOTE: King County had adopted the International Codes. Title 16 has been amended in 2009.
2) Zoning Ordinance	Y	N	N	N	Zoning (King County Code Title 21A) Title 21A has been amended in 2009.
3) Subdivision Ordinance	Y	N	N	N	Land Segregation (King County Code Title 19A) Title 19A has been amended in 2009.
4) Special Purpose Ordinances (floodplain management, critical or sensitive areas)	Y	N	N	N	Critical Areas Ordinance (CAO) (King County Code chapter 21A.24); Floodplain management (King County Code 21A.24.230-.270) State Environmental Policy Act (SEPA), (King County Code chapter 20.44), Ch. 43.21C RCW
5) Growth Management	Y	N	N	Y	King County Countywide Planning Policies, 10/2008, Washington State Growth Management Act (GMA), 1990
6) Floodplain Management/ Basin Plan	Y	N	N	N	King County Flood Hazard Management Plan, Ord. 15673, 1/17/2007, King County Flood Control District, Ord. 15728, 4/2007, King County basin plans (King County Code chapter 20.14), National Flood Insurance Program (NFIP)
7) Stormwater Management Plan/ordinance	Y	N	N	Y	Surface Water Management (King County Code Title 9) Title 9 has been amended in 2009, Surface Water Design Manual, updated in 2009, National Pollutant Discharge Elimination System (NPDES) phase I municipal stormwater permit updated in 2009
8) General Plan or Comprehensive Plan	Y	N	N	Y	King County Comprehensive Plan, 10/6/2008,
9) Capital Improvements Plan	Y	N	N	N	Capital Improvements Plans for roads, transit, airport, stormwater, wastewater,

LEGAL AND REGULATORY CAPABILITY					
Regulatory Tools (Codes, Ordinances., Plans)	**Local Authority (Y or N)**	**Prohibitions (State or Federal)**	**Higher Jurisdictional Authority (Y or N)**	**State Mandated (Y or N)**	**Comments**
					solid waste, parks, open space, and flood hazard management are approved annually as part of the King County budget process
10) Site Plan Review Requirements	Y	N	N	N	King County Code Title 21A (Zoning), 19A (Land Segregation) and 16 (Building and Construction Standards) all require site plan review
11) Habitat Conservation Plan	Y	N	N	N	Lake Washington, Cedars, Sammamish Watershed (WRIA 8) Chinook Salmon Conservation Plan, 7/2005, Snohomish River Basin Salmon Conservation Plan (WRIA 7), 6/2005, Green/Duwamish & Central Puget Sound Watershed Plan (WRIA 9)
12) Economic Development Plan	Y	N	N	N	King County Business Development and Contract Compliance Program
13) Emergency Response Plan	Y	N	N	Y	King County Comprehensive Emergency Management Plan, December 2008
14) Shoreline Management Plan	Y	N	N	Y	Shoreline Management (King County Code Title 25) update in process , King County Shoreline Management Master Program, Ord. 3692, 5/1/1978, Shoreline Master Program Guidelines, Ch. 173-26 WAC, 1/17/2004, Washington State Shoreline Management, Ch. 90.58 RCW, 1971, Coastal Zone Management Act, 1972
15) Post Disaster Recovery Plan	N	N	N	N	NA
16) Post Disaster Recovery Ordinance	N	N	N	N	NA
17) Real Estate Disclosure req.	Y	N	N	Y	Washington State Real Property Transfer Disclosure Statement, Ch. 64.06 RCW, Amended 2003-2004
18) Other					

ADMINISTRATIVE AND TECHNICAL CAPABILITY		
Staff/ Personnel Resources	**Available (Y or No)**	***Department/ Agency/Position***
1) Planner(s) or Engineer(s) with knowledge of land development and land management practices	Y	King County Water & Land Resources Division, King County Department of Development and Environmental Services
2) Engineer(s) or Professional(s) trained in construction practices related to buildings and/or infrastructure	Y	King County Water & Land Resources Division, King County Department of Development and Environmental Services, King County Roads Services Division
3) Planners or engineers with an understanding of natural hazards	Y	King County Water & Land Resources Division, King County Department of Development and Environmental Services, King County Road Services Division
4) Public Information officer/liaison	Y	All King county Government Agencies,
5) Webmaster- website technical capability	Y	All King county Government Agencies
6) Floodplain Manager	Y	King County Water & Land Resources Division King County Department of Development and Environmental Services
7) Surveyor(s)	Y	King County Department of Development and Environmental Services, King County Road Services Division
8) Personnel skilled or trained in “GIS” applications	Y	King County Water & Land Resources Division, King County Department of Development and Environmental Services, King County Geographic Information Systems Center
9) Scientist familiar with natural hazards in King County.	Y	King County Water & Land Resources Division King County Department of Development and Environmental Services
10) Emergency Manager	Y	King County Office of Emergency Management
11) Grant Writer(s)	Y	King County Water & Land Resources Division
12) Staff with expertise or training in benefit/cost analysis	Y	King County Office of Emergency Management King County Water & Land Resources Division, River and Floodplain Management Program

FISCAL CAPABILITY	
Financial Resources	**Accessible or Eligible to use (yes/no/Don't know)**
1) Community development Block Grants (CDBG)	Yes
2) Capital Improvements Project Funding	Yes
3) Authority to Levy Taxes for specific purposes	Yes
4) User fees for water, sewer, gas or electric service	Yes
5) Impact Fees for homebuyers or developers of new development/homes	Yes
6) Incur debt through general obligation bonds	Yes
7) Incur debt through special tax bonds	Yes
8) Incur debt through private activity bonds	Don't Know
9) Withhold public expenditures in hazard-prone areas	No
10) State sponsored grant programs such as FCAAP	Yes
11) Other-Flood Control District Funding	Yes

Vulnerability Assessment and Risk Analysis Endnotes

0.5 State of Washington, Emergency Management Division, Hazard Mitigation Section staff, September, 2009

1 King Department of Natural Resources and Parks, Water and Land Resources Division, River and Floodplain Management, September 2009

2 2006 *King County Flood Hazard Management Plan*, King Department of Natural Resources and Parks, Water and Land Resources Division, Final, January 2007

3 FEMA, Level 1 HAZUS – MR3

4 *Washington State Hazard Mitigation Plan* – Regional 6 Profile, Sept 2003 Draft